OCCASIONAL PAPER No. 55 April 9, 1936.

SOUTHERN FOREST EXPERIMENT STATION

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THE WEED PROBLEM

AT THE

STUART FOREST NURSERY, POLLOCK, LA.

By

A.D. McKellar, *Junior Forester*

This paper releases data gathered in current investigations at the Southern Forest Experiment Station, and is subject to correction or modification following further investigations.

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INTRODUCTION

The purpose of this paper is to describe the weed-eradication problem at the Stuart Forest Nursery and to present data which will be useful to other nurserymen, to botanists and agronomists interested in weed species, and to investigators in chemical control of weeds.

The Stuart Nursery was established in September 1933 with a planned capacity of 10 million seedlings, which was expanded in 1935 to 50 million. Weed control at once became of major importance. During 1934 the cost of labor for weeding was $1.12 per thousand seedlings or 25 percent of the total cost of producing planting stock. The problem has been vigorously attacked by the Forest Service administrative staff, with visible progress, since the weeding cost for 1935 at the same wage rate was only 22 cents per thousand seedlings [2]. The Southern Forest Experiment Station also has undertaken studies of the weed population and of control methods.

STATEMENT OF PROBLEM

The nursery is situated about 6 miles west of Pollock, La., and 15 miles north of Alexandria. The topography is gently rolling, the nursery being located on a hill which slopes to the south. The soil is Caddo very fine sandy loam with a heavy yellow sandy clay subsoil from 4 to 10 inches beneath the surface, and is moderately acid (pH about 5.7). Its original area was 112 acres, of which a gross area of 17 acres was sowed to pine in 1934. The area occupied by the 1934 nursery had lain fallow for about 15 years after agricultural use. No green manure crops immediately preceded the pines. In 1935 the area of the nursery was increased to 140 acres, with approximately 51 acres sowed. This area was entirely cut-over pine land, except for 16 acres which were cleared in 1934 and sowed to cowpeas twice or to cowpeas once and to a mixture of *Sesbania* and Crotolaria once during 1934. The combined cost of the green manure was $15.75 per acre. Nursery practice makes it necessary to rotate crops, and while approximately 51 acres were sowed to pine seed, 27 acres were sowed at the same time to leguminous plants, which were afterwards plowed under. The remaining acreage was purposely allowed to lie fallow.

Hot, dry summers and mild to moderately cold, wet winters are characteristic of the region. The maximum surface soil temperature recorded in 1935 was 137° F. About 50 inches of rain falls annually.

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[1] Acknowledgement is made to Mr. A.D. Read, Nurseryman, for cost figures and other data, and to Dr. L.J. Pessin, Miss Anna Haas, and Dr. C.A. Brown for plant identifications.

[2] Based on fall inventory.

Longleaf and slash pines are the principal species produced. The 1935 fall inventory showed 28 million slash, 8 million longleaf, 4 million shortleaf, and 1 million loblolly pine seedlings. Seeds are sowed in February, March, and April and the seedlings lifted for planting in the field the following December, January, and February.

Seed is sowed in beds 4 feet wide and 100 feet long. The soil is first plowed, then disced several times. The beds are thrown up and each bed worked by a roto-tiller, a mechanical soil pulverizer. Surface raking, following deep working with long-tined "potato hooks", completes the preparation. Seed is sowed in drills on top of the soil by a mechanical seeder and pressed firmly into the ground by a heavy roller. The drills are 6 inches apart and run lengthwise of the bed. The quantity of seed sowed is computed so as to insure a stand of 12 to 15 longleaf or 8 to 20 slash, shortleaf, or loblolly per linear foot. The beds are covered with burlap mulch during germination.

At the time of lifting, when the seedlings average 10 months of age, the stems of slash pine average about 8 inches high, those of shortleaf and loblolly about 4 to 6 inches, and the needles of longleaf, which has no stem at that age, about 12 inches.

Weeds are undesirable in the forest nursery for the same reasons that they are objectionable in farm crops; they usurp soil moisture and nutrients and, if allowed to grow, seriously compete with the pines for space and light. If left, the weeds materially reduce the number of plantable trees at the end of the season (*12*) [3] and interfere mechanically with the lifting of the seedlings. Most of the weeds present are indigenous to the area. Some originate from wind-blown seed. Many of those on the 1934 site were typical of agricultural land. They probably came in as a result of previous cultivation or were introduced by fertilizing with barnyard manure during the time the land was being farmed. (See fig. 1.)

Hand weeding is the chief method of controlling weeds at the Stuart Nursery. Weeding begins in April soon after the burlap mulch is lifted and continues through October. By this time the season has passed for many weeds and the seedling crowns have closed so that few weeds come in. Each bed receives about 5 weedings at approximately monthly intervals. Data for 1935 show that the longleaf was weeded 6 times, slash 4 to 5, shortleaf 6 to 7, and loblolly 4 times. These differences are probably attributable to site and degree of infestation rather than to species of trees. The following tabulation shows the number of man-days' labor (C.C.C. enrollees) required for weeding for all species, by months, per net acre of seedlings:

Month	1934	1935
April	32	9
May	205	70
June	188	69
July	200	51
August	126	15
September	77	7
October	20	Negligible

In 1934, 1.9 man-days were required per bed and in 1935 only 0.39 man-day. This reduction in labor was due principally to the change of site from fallow soil to

[3] Italic figures in parentheses refer to Literature Cited at end of this paper.

FIGURE 1. -- A bed of longleaf pine heavily infested with weeds, 1934.

new ground where common field weeds have not become established, but was also partly owing to greater efficiency in the work. It should be noted that the heavy weeding job falls in May, June, and July.

As an aid to hand weeding, "spuds" are used. A spud is a piece of 1/8- by 3/4-inch strap iron 6 inches long sharpened at one end and bent slightly to accommodate the thumb. The spud protects the fingers and greatly facilitates the pulling of deep-rooted plants. Benches which straddle the bed have been used to sit on when weeding, but were found cumbersome and unnecessary. Long-handled, triangular beet-hoes were used in 1935 to remove weeds between the drills of seedlings. These are practicable only where seed is drill-sowed and while the seedlings are small. The administrative staff found that, on beds where weeds were abundant, hoeing reduced the time for weeding by 40 percent in the first weeding and 7.5 percent in the second. The trees were too large after the second weeding to permit hoeing. On an area where weeds were sparse a saving in time of 8.7 percent and 13.7 percent in the first and second weedings, respectively, resulted. One disadvantage of the hoes, however, is that the bark of some seedlings is nicked, permitting attack by fungi. Hoeing and hand weeding are simpler when drills run across the bed, but this is often impractical, since most mechanical seeders sow lengthwise. In dry weather, beds are watered before weeding. Removing weeds from soft ground is easier, faster, and results in less injury to the seedlings than removing them from hard soil.

During the summer and fall months a patrol consisting of several men is maintained at the Stuart Nursery to detect and remove weeds which are going to seed in the beds. This is a very desirable practice, as it is inevitable that a few small plants are missed in the general weeding operation and these might mature before the next weeding.

Where very serious perennial weeds have been found, the soil has been dug up, pulverized, and sifted to remove underground parts of the plant. Fortunately, only a few patches of this kind have occurred and these have been immediately destroyed. Chemical control is yet in the experimental stage.

Continuous cultivation is a valuable weed-control measure. In one southern nursery the weeding cost for 1934 on beds placed on land that had been fallow for some years was 4.59 times as much as for beds on land that had been rotated with seedbeds and cover crops for several years.[4] Potato-hooking the beds, or any tillage practice that removes vegetative parts capable of regenerating the plant, is advisable. One thorough operation of this kind may save several weedings later (*12*). Deep plowing probably destroys many weed seeds, but this is not entirely effective. Some weed seeds are known to remain viable for many years when buried in the soil (*5*). Small, tender weeds are more easily destroyed than the seeds. Harrowing the soil several weeks before the date of sowing may cause the germination of weed seeds and the small plants can then be raked out at the time of bed preparation. This method is applicable, principally, where the sowing of the crop species can be postponed until after the usual time when weed seeds begin germinating.

As weed pests, grasses and forbs[5] are about equal in importance at the Stuart Nursery. The grasses grow rapidly and must be removed early to prevent disturbance of the soil. Many species, such as goosegrass, *Eleusine indica*, and *Paspalum plicatulum* spread out from the base or form dense bunches which crowd out nearby pine seedlings. Other species, such as carpet grass, *Axonopus compressus*, and Bermuda grass, *Cynodon dactylon*, creep extensively, forming thick turf. Of the grasses, the species of *Panicum*, *Paspalum*, *Andropogon*, and *Aristida* probably are most abundant. Some species are particularly difficult to eradicate because of rapid regeneration from vegetative parts. Coco-grass, *Cyperus rotundus*, Bermuda grass, and Johnson grass, *Sorghum halepense*, are of this type. Others are a nuisance because of their abundance. Some of these are *Fimbristylis geminata* (a sedge), *Aristida longespica* (three-awn), and *Polypremum procumbens* (a forb).

Some of the genera of weeds which occur at the Stuart Nursery, grouped by season of flowering, are given in the following list; the nomenclature follows Small (*8*) or Hitchcock (*3*):

Spring (March, April, May):
Diodella, Scirpus, Croton, Plantago, Cerastium, Sisyrinchium, Xanthoxalis, Ionoxalis, Hypoxis, Ranunculus, Cyperus, Serinia, Polypremum.

Summer (June, July, August):
Panicum, Paspalum, Andropogon, Eleusine, Digitaria, Axonopus, Cynodon, Fimbristylis, Diodella, Sida, Chamaecrista, Helenium, Setaria, Polypremum, Oldenlandia, Chamaesyce.

Fall (September, October, November):
Aristida, Polypremum, Oldenlandia, Chamaesyce.

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[4] Erambert, G. F., and Averell, James L. Review of Huberman's unpublished "Memorandum on conclusions and recommendations resulting from the Ozark nursery inspection trip, October 20, 1935."

[5] A forb is a non-grasslike herb.

Exact times of germination and establishment of annual weeds are not given, as many of them, particularly the grasses, cannot be identified before the flower appears. Perennial weeds are present all year. Seed dissemination may be expected generally from 3 to 6 weeks after flowering. It is advisable to attack the weeds before or atleast not later than the flowering period to prevent maturing of seed.

WEED INVESTIGATIONS

The Southern Forest Experiment Station's work upon weeds during 1935 consisted chiefly of collection and identification of plants occurring in and near the nursery, preservation of the specimens in the herbarium, determination of seasonal succession and life history of weeds, and simple experiments in chemical and mechanical control. More than 100 species of weeds have been collected, most of which occur in the beds.

For a study of life history, a portion of one bed was left unsowed and the characteristics of the weeds which came in naturally were studied. Also, weed seeds were sowed and young weeds transplanted on another plot. Interesting data may be obtained from such an area; however, it may also be a source of weed-seed infestation unless carefully watched. A bed outside the nursery probably would serve as well.

Zinc sulphate, 6.00, 8.00, and 10.00 grams per square foot; zinc chloride, 3.75, 5.00, and 6.25 grams per square foot; and sulphuric acid, 6.00, 8.00, and 10.00 grams per square foot, were tested for effectiveness in controlling weeds. The percentages of normal solutions represented by these concentrations are as follows:

Zinc sulphate	6.00 grams	13.52 percent normal
" "	8.00 "	17.94 " "
" "	10.00 "	22.34 " "
Zinc chloride	3.75 "	10.92 " "
" "	5.00 "	14.53 " "
" "	6.25 "	18.12 " "
Sulphuric acid	6.00 "	24.19 " "
" "	8.00 "	32.12 " "
" "	10.00 "	39.99 " "

Paper mulch also was tried as a mechanical means of suppressing weeds between drills.

LIST OF WEEDS OBSERVED AT STUART FOREST NURSERY

In the following list, the scientific and most of the common names of grasses have been taken from Hitchcock's manual(*3*) and names of other plants from Small's 1933 manual (*8*).The "Seed List" (*10*) of the U. S. Department of Agriculture has also been freely consulted for common names. In certain instances, departures from the Latin nomenclature of Small's flora are shown by parenthesizing such names and preceding them by the name preferred in the U.S. Department of Agriculture. For this, we have relied on a reviewer in the section of Range Forage Investigation of the Forest Service. In certain instances, also, two common names are given, the first being the preferred nomenclature indicated by the above-noted reviewer, the second, in quotation marks, being that given by Small or Hitchcock. The plants are grouped by families. The approximate flowering period also is given. Those known to be perennials are designated by (P).

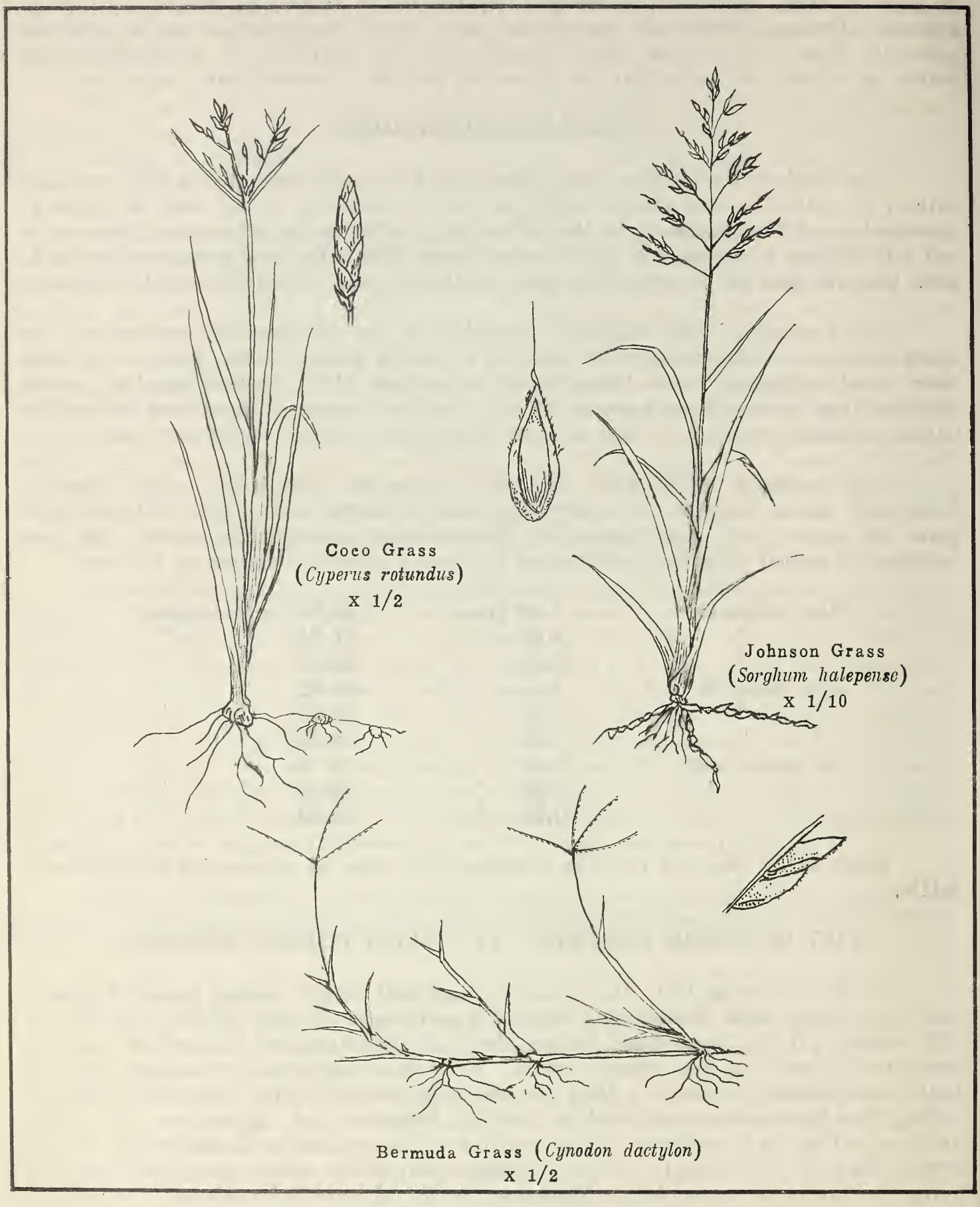

FIGURE 2. -- Three obnoxious weeds.

Alliaceae, Onion family	
Nothoscordum bivalve, false-garlic (P)	Spring
Alsinaceae, Chickweed family	
[6] *Cerastium viscosum,* sticky mouse-ear; "mouse-ear chickweed"	Spring
Ambrosiaceae, Ragweed family	
Ambrosia elatior, common ragweed; "bitterweed"	Summer
Ammiaceae, Carrot family	
Eryngium synchaetum, button-snakeroot	Summer
Brassicaceae, Mustard family	
Carara didyma, swinecress	Spring
Lepidium virginicum, peppergrass	Spring
Campanulaceae, Bellflower family	
Specularia perfoliata, Venus lookingglass	Spring
Carduaceae, Thistle family	
Chrysopsis graminifolia (*Pityopsis graminifolia*), grassleaf golden-aster	Summer
Coreopsis crassifolia, tickseed	Spring
Erigeron ramosus, wild-daisy; fleabane	Spring
Gnaphalium falcatum, cudweed	Spring-Summer
Gnaphalium spathulatum, cudweed	Spring-Summer
[6] *Helenium tenuifolium,* bitterweed	Summer
Lacinaria pycnostachya, gayfeather; "blazing-star" (P)	Summer
Lacinaria squarrosa, gayfeather; "blazing-star" (P)	Summer
Rudbeckia alismaefolia, coneflower	Summer
Solidago altissima, goldenrod	Summer
Vernonia angustifolia, ironweed (P)	Summer
Cassiaceae, Senna family	
Chamaecrista littoralis, "sensitiveplant"	Summer
Cichoriaceae, Chicory family	
Serinia oppositifolia	Spring
Convulvulaceae, Morning-glory family	
Thyella tamnifolia, "tie-vine"	Fall
Cyperaceae, Sedge family	
Carex Leavenworthii, sedge (P)	Spring-Summer
Cyperus pseudovegetus, sweetrush (P)	Spring-Summer
[6] *Cyperus rotundus,* coco-grass (P)	Summer
Fimbristylis baldwiniana, sedge	Fall
Fimbristylis castanea, sedge	Spring-Summer
[6] *Fimbristylis geminata,* sedge	Summer
Rynchospora compressa, sedge	Summer
Scirpus carinatus, bulrush	Spring-Summer
Scleria ciliata, nutrush	Spring-Summer

[6] Particularly obnoxious or abundant species.

Droseraceae, Sundew family	
Drosera brevifolia, dwarf-sundew	Spring
Epilobiaceae, Evening-primrose family	
Ludwigia linearis, seedbox	Summer
Peniophyllum linifolium	Summer
Raimannia laciniata	Spring
Euphorbiaceae, Spurge family	
Acalypha gracilens, three-seed; "three-seeded mercury"	Summer
Chamaesyce (*strictospora?*), groundspurg (Small's 1913 manual)	Summer-Fall
Croton Engelmannii (skunkweed)	Summer
Tithymalopsis corollata, flowering spurg (P)	Summer
Fabaceae, Pea family	
Cracca angustifolia, hoary-pea (P)	Summer
Psoralea pedunculata (*Orbexilum pedunculatum*), congo-root (P)	Spring
Stylosanthes bifolia, pencilflower (P)	Spring
Trifolium procumbens, mignonette clover; "low hop-clover"	Spring
Geraniaceae, Geranium family	
Geranium carolinianum, Carolina cranesbill	Spring
Hypericaceae, St. Johnswort family	
Hypericum acutifolium, St. Johnswort	Summer
Sarothra Drummondii	Summer
Sarothra gentianoides, pineweed	Summer
Ixiaceae, Ires family	
Sisyrinchium albidum, blue-eyed-grass (P)	Summer
Sisyrinchium Brownei, blue-eyed-grass (P)	Summer
Juncaceae, Rush family	
Juncus dichotomus, rush	Spring
Juncus marginatus, rush	Summer
Juncus robustus, rush	Summer
Juncus tenuis, hemprush	Summer
Lamiaceae, Mint family	
Hedeoma hispida, rough pennyroyal; "mock pennyroyal" (Small's 1913 manual)	Summer
Salvia lyrata, lyre-leaf sage	Spring
Scutellaria integrifolia, skullcap	Summer
Leucojaceae, Amaryllis family	
[6] *Hypoxis hirsuta,* stargrass	Spring
Lobeliaceae, Lobelia family	
Lobelia leptostachys, lobelia	Summer

[6] Particularly obnoxious or abundant species.

Malvaceae, Mallow family	
Modiola caroliniana, "cheese plant"	Spring
[6] *Sida rhombifolia*	Summer
Melastomaceae, Meadowbeauty family	
Rhexia mariana, pale meadowbeauty (P)	Summer
Mimosaceae, Mimosa family	
Leptoglottis Nuttallii, sensitivebriar (P)	Summer
Orchidaceae, Orchid family	
Limodorum multiflorum, grass-pink	Spring
Oxalidaceae, Woodsorrel family	
Oxalis macrantha (*Xanthoxalis macrantha*), yellow woodsorrel	Spring
Oxalis stricta (*Xanthoxalis stricta*), common yellow woodsorrel	Spring
Oxalis violacea (*Ionoxalis violacea*), violet woodsorrel	Spring
Plantaginaceae, Plantain family	
[6] *Plantago aristata,* bottlebrush plantain	Summer
[6] *Plantago heterophylla,* plantain	Spring-Summer
[6] *Plantago virginica,* paleseed plantain	Spring-Summer
Poaceae, Grass family	
Agrostis hiemalis, ticklegrass	Summer
[6] *Andropogon virginicus,* broomsedge (P)	Summer-Fall
[6] *Aristida longespica,* three-awn	Summer-Fall
[6] *Axonopus compressus,* carpet grass	Summer
Brachiaria extensa	Summer
[6] *Cynodon dactylon,* Bermuda grass (P)	Summer
[6] *Digitaria sanguinalis,* crabgrass	Summer
[6] *Digitaria violascens*	Summer
[6] *Eleusine indica,* goosegrass	Summer
Hordeum pusillum, little barley	Summer
Panicum anceps	Summer
[6] *Panicum angustifolium*	Summer
[6] *Panicum lanuginosum*	Summer
[6] *Paspalum dilatatum,* Dallis grass (P)	Summer
Paspalum floridanum, * Florida paspalum (P)	Summer
[6] *Paspalum plicatulum,* * Savannah paspalum (P)	Summer
[6] *Paspalum supinum,* * longleaf paspalum (P)	Summer
Poa annua, annual bluegrass	Summer
[6] *Setaria lutescens,* yellow bristlegrass	Summer
[6] *Sorghum halepense,* Johnson grass (P)	Summer
Triodia stricta, * longspike triodia	Summer
Polygalaceae, Milkwort family	
Polygala Curtissii, Curtiss polygala; "button-rosy"	Summer

[6] Particularly obnoxious or abundant species.

* Name not in (*3*); supplied by Div. Range Forage Investigation, Forest Service.

Polygonaceae, Buckwheat family	
Persicaria hydropiperoides, smartweed; "mild waterpepper"	Summer
Ranunculaceae. Crowfoot family	
[6] *Ranunculus fascicularis,* early wood buttercup	Spring
Rhinanthaceae, Figwort family	
Agalinis aphylla, agalinis; "gerardia"	Fall
Linaria canadensis, blue toadflax	Spring
Rubiaceae, Madder family	
Diodia teres (*Diodella teres*), buttonweed	Summer-Fall
Diodia tetragona, buttonweed (P)	Summer
[6] *Houstonia pusilla,* bluet	Spring
[6] *Oldenlandia Boscii,* (P)	Summer-Fall
Richardia scabra, Mexican-clover	Fall
Solonaceae, Potato family	
Physalis virginiana, groundcherry	Summer
Spigeliaceae, Logania family	
Polypremum procumbens	Fall
Tetragoniaceae, Carpetweed family	
Mollugo verticillata, carpetweed	Spring-Fall
Verbenaceae Vervain family	
Verbena Halei, verbena	Spring
Violaceae, Violet family	
Viola primulifolia, running violet; * (white violet)	Spring

* Local common name, not given by Small.

The above is a partial list only. Some species occurring at the Nursery have not yet been collected. All species were identified by the writer, and his identification was checked by Miss Anna Haas at the Southern Station, and by Professor Clare A. Brown at the Botany Department of Louisiana State University. Specimens are preserved in the herbarium of the Southern Forest Experiment Station in New Orleans, and duplicates are preserved at the Stuart Nursery and in the herbarium of the Botany Department of Louisiana State University, Baton Rouge, La.

Brief descriptions of several important weeds found at the Stuart Nursery follow: The three following species are important because they are particularly obnoxious and difficult to eradicate.

(1) *Cyperus rotundus,* coco-grass, is a perennial sedge 8 to 24 inches tall with a tuberous rootstock. The inflorescence is a cluster of purplish brown spikelets about 1/4-inch to 1 inch long. The tubers or "nuts" on the roots increase rapidly in number and are very persistent. These must be eradicated and the fruit prevented from maturing.

[6] Particularly obnoxious or abundant species.

(2) *Sorghum halepense,* Johnson grass, is a perennial grass 18 to 60 inches tall with a stout, creeping rootstock. The inflorescence is an open panicle with spikelets about 3/8-inch long, bearing deciduous short awns. This plant has been known to produce hydrocyanic acid in sufficient amounts to poison grazing animals.

(3) *Cynodon dactylon,* Bermuda grass, is a common perennial lawn grass 4 to 16 inches high with extensively creeping stolons and rootstocks. The spikelets are about 1/16-inch long on 4 to 5 digitate spikes 3/4-inch to 2 inches long. The leaves are narrow.

The following three species are important because of their great abundance.

(1) *Fimbristylis geminata* is an annual sedge 2 to 8 inches high with reddish brown, umbelled spikelets 1/16- to 3/16-inch long. It is shallow-rooted.

(2) *Aristida longespica,* three-awn, is a slender-stemmed annual grass 6 to 20 inches high with awned spikelets in an appressed panicle. It is abundant in late summer and fall. Its narrow leaves are difficult to distinguish in longleaf pine beds.

(3) *Polypremum procumbens* is a small, diffusely branching forb with linear leaves about 1/2-inch long and white tubular flowers 3/16-inch in diameter. Branches are 4 to 12 inches long. This plant forms dense mats in the bed.

EXPERIMENTS IN WEED CONTROL

Chemical treatment

In 1934 sixteen 4- by 4-foot plots sowed to longleaf pine were treated with zinc sulphate to test its effect on weeds and pine seedlings. It was applied 24 hours before sowing the seed, at the rates of 6.00, 8.00, 10.00, and 12.00 grams per square foot in 3 gallons of water per plot. Treatments and the check were replicated four times. Zinc sulphate effectively controlled the forbs but did not control the grasses. Pine germination was slightly lower in the treated plots than in the checks, but the chemical did not retard the growth of the pine seedlings. (See Fig. 3)

In 1935 the following treatments were tried: (See p. 5)

Zinc sulphate, 6.00, 8.00, and 10.00 grams per square foot.

Zinc chloride, 3.75, 5.00, and 6.25 grams per square foot (zinc content equivalent to that in zinc sulphate).

Sulphuric acid, 6.00, 8.00, and 10.00 grams per square foot.

Each treatment was replicated four times, once in each of four blocks. The treatments were randomized in each block. The chemicals were applied 24 hours before sowing, in 500 cc. of water per square foot. The plots were 1 by 2 feet, boxed in by a bottomless wood frame 10 inches deep, the top of which was at ground level. Several days before sowing, the top 2 inches of soil in these plots was removed and steamed for one hour to kill weed seeds already present. One half of each plot was drill-sowed to longleaf and one half to slash pine. One hundred seeds of each of

FIGURE 3. -- A portion of a longleaf pine bed in 1934 showing plot 6b treated with 6 grams of zinc sulphate per square foot, plot 10b treated with 10 grams of zinc sulphate per square foot, and a check plot (x) between. Note the number of weeds in the check as compared to the treated areas.

three species of weeds, *Polypremum procumbens, Sida rhombifolia,* and *Hypericum acutifolium,* were broadcast on each square foot. These are forbs. No grasses were used because the seed was not available. Two blocks of plots were used for germination counts of pine and weed seeds. These were covered with half-inch mesh wire screen and two layers of cheesecloth to prevent the entrance of additional weed seed. The other two blocks were used to study survival of weeds and pine. All plots were covered with burlap mulch after sowing.

Results show that weed seeds germinate in the presence of these chemicals. The average [7] number germinated per square foot, by treatments and species, is shown in table 1.

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[7] Average of plots in germination study blocks. Data as of December 12, 1935.

TABLE 1. -- *Average number of seed germinated per square foot, by treatments and species*[1]

Treatment	*Sida rhombifolia*	*Polypremum procumbens*	*Hypericum acutifolium*	Unsowed	
				Grasses	Other
Zinc sulphate					
6 grams	43	72	10	9	5
8 grams	48	64	10	5	5
10 grams	40	53	2	8	0
Zinc chloride					
3.75 grams	35	60	2	7	2
5.00 grams	50	69	5	6	1
6.25 grams	36	62	0	2	1
Sulphuric acid					
6 grams	57	57	12	25	11
8 grams	50	70	21	12	10
10 grams	54	38	15	23	9
Check	56	66	10	22	21

[1] Since 100 seeds of each species were sown on each square foot, these figures are equivalent to germination percent.

All concentrations of zinc sulphate and zinc chloride were effective in killing forbs after germination. Present indications are that one application per year is sufficient. Sulphuric acid in the concentrations used was not effective. Weed survival is shown in table 2.

TABLE 2. -- *Weed survival, by treatment*

Date	Weeds per square foot [1]																			
Chemical	Zinc sulphate						Zinc chloride						Sulphuric acid						Check	
Grams	6.00		8.00		10.00		3.75		5.00		6.25		6.00		8.00		10.00			
Weeds	Forbs	Grasses	Forbs	Grasses	Forbs	Grasses	Forbs	Grasses	Forbs	Grasses	Forbs	Grasses	Forbs	Grasses	Forbs	Grasses	Forbs	Grasses	Forbs	Grasses
May 1, 1935	31	1	30	1	37	0	34	1	25	0	25	0	40	1	36	1	36	0	60	1
May 7, 1935	38	0	42	0	53	0	47	0	36	0	42	0	47	1	44	1	43	0	88	1
May 13, 1935	12	1	12	1	12	1	20	1	11	0	1	0	31	2	25	1	18	2	48	1
May 21, 1935	1	1	0	1	3	0	1	1	1	0	0	0	30	2	23	2	20	3	24	2
May 27, 1935	1	1	1	1	1	0	0	1	1	0	0	0	30	3	28	2	17	4	20	3
June 10, 1935	1	0	1	0	0	0	0	1	0	0	0	0	29	4	28	2	17	5	22	2
July 9, 1935	0	1	0	0	0	0	0	1	1	0	0	0	28	5	26	2	16	5	20	3
August 10, 1935 [2]	0	1	0	1	0	0	0	1	1	0	0	0	24	2	22	2	14	3	23	2
September 13, 1935	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	1	0	2	0
October 11, 1935	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
November 18, 1935	0	3	0	2	0	2	0	3	0	2	0	1	0	1	0	1	0	2	0	2
December 12, 1935	7	2	6	2	7	2	13	4	5	2	5	1	1	0	6	2	8	2	7	2

[1] Average of 2 plots in survival study blocks. The forbs include a few weeds of unsowed species.
[2] All weeds were removed from the plots August 10, 1935, to release pine seedlings.

The total germination of slash pine [8] was not affected by the chemicals.

Table 3 shows the total germination, by treatments.

TABLE 3. -- *Total germination of slash pine per square foot, by treatments* [1]

	Zinc sulphate			Zinc chloride			Sulphuric acid			Check [2]
Grams	6.00 [2]	8.00 [2]	10.00	3.75	5.00	6.25	6.00	8.00	10.00	
Total germination	57	-	65	65	62	65	66	66	73	72

[1] Since 100 seeds were sowed on each square foot these figures are equivalent to germination percent. They represent the average of two plots in the germination study blocks.

[2] Because of errors in seed count the figure for zinc sulphate 8 grams is omitted and those of zinc sulphate 6 grams and the check are based on one plot only; other figures are based on two plots.

Final survival of slash pine was consistently high except for the zinc chloride 6.25 gram treatment. The pine surviving December 12, 1935, is shown in table 4.

TABLE 4. -- *Survival of slash pine by treatments* [1]

	Zinc sulphate			Zinc chloride			Suphuric acid			Check
Grams	6.00	8.00	10.00	3.75	5.00	6.25	6.00	8.00	10.00	
Survival	62	60	76	93	53	25	75	79	56	57

[1] These figures represent the percentages of the germinated and established seedlings which survived as of December 12, 1935.

The final averages of stem height, stem diameter, and root length of the slash pine seedlings are shown in table 5. There appears to be no serious detrimental effect on these factors from the use of the chemicals. The roots of the treated seedlings were fibrous and spreading and compared favorably with the check. All the plots were sowed late in the season and therefore the best development was not obtained in either the treated or the check plots. The presence of the weeds may have retarded the development of the seedlings.

[8] Longleaf pine was not considered because of low germination caused by poor seed.

TABLE 5. -- *Final measurements of slash pine* [1]

Treatment	Stem length [2]	Stem diameter [2]	Root length [2]
	Centimeters		
Zinc sulphate			
6 grams	8.6	.23	8.2
8 grams	10.3	.36	8.9
10 grams	8.6	.21	8.3
Zinc chloride			
3.75 grams	10.3	.23	11.5
5.00 grams	9.4	.24	10.8
6.25 grams	9.7	.31	14.1
Sulphuric acid			
6 grams	10.0	.23	9.9
8 grams	10.0	.22	9.0
10 grams	9.9	.26	8.4
Check	10.8	.30	10.2

[1] Seedlings lifted and measured December 12, 1935.
[2] Arithmetic averages.

The rapidity of germination of the pines was slightly reduced by all concentrations of zinc sulphate, zinc chloride, and sulphuric acid, except the 10 grams zinc sulphate treatment, which slightly increased the speed of germination.

As a check on the effectiveness of the steaming for sterilization, one additional plot in each block was left unsteamed and sowed to pine but not to weed seed. These were not chemically treated. Weeds other than those sowed appeared in the steamed plots about as abundantly as in the unsterilized plots, indicating that steaming for one hour is not effective. It is believed that the germinated seeds were initially present in the top soil rather than passing through the screen or germinating below the 2-inch soil level. Most of these were grasses.

These experiments confirm previous tests (*12*) at Bogalusa in 1924, 1925, 1926, and 1928, and at the Stuart Nursery in 1934, in which it was found that zinc sulphate was effective in controlling forbs but failed in the case of grasses. Experiments in England (*9*) also showed that zinc sulphate applied to soil used as a seed cover controlled weeds.

Many chemicals other than those listed have been used with varying success to control weeds. The object usually has been to destroy all vegetation, as along roadsides or around buildings. It is easier to accomplish this than to find chemicals which are selective in their action; i.e., which kill weeds without injury to crop plants. Chemicals, usually applied as sprays, are either corrosive in nature or actually poisonous upon penetrating the leaves, stems, or roots. Some weed killers in common use but not tried at the Stuart Nursery are given below:

a. Iron sulphate, 2 pounds per gallon of water.

b. Sodium arsenite, 1 to 5 pounds per 25 gallons of water.

c. Common salt, 3 pounds per gallon of water.

d. Dowicide-H, 10.8 ounces to 12 square feet of bed.

e. Sodium chlorate, 1 to 1.5 pounds per gallon of water.

f. Gasoline, full strength.

g. Kerosene, full strength.

h. Crude oil, full strength.

Extreme care should be exercised in using sodium chlorate, which is very inflammable, and sodium arsenite, which is poisonous. Dowicide-H is a commercial lumber dip.

Paper mulch

In 1935 an attempt was made to control weeds by covering the soil between drills with strips of black mulch paper. The paper was held down tightly by wire pins. Check plots were left without the mulch. In the mulched plots, weeds came up between the seedlings in the drills, which, of course, could not be covered by the paper. Comparison of time required for periodic hand weeding revealed little difference between treated and check plots. A slight advantage of the mulched plots in the spring was offset by a disadvantage in the fall. In view of the cost and time required to lay the paper, mulching cannot be justified.

These results are confirmed by experiments conducted by the Southern Forest Experiment Station at Bogalusa, La., and Camp Pinchot, Fla., and by the Great Southern Lumber Company at Bogalusa, in which it was found that "...the nature of the crop to be grown is such that 20 to 30 percent of the soil must be exposed as contrasted with perhaps 5 to 10 percent in the case of such crops as eggplants, tomatoes, and beans. The exposure of so much soil gives the weeds plenty of chance to come up among the crop plants, and thus one of the principal advantages of the paper mulch is lost"(*12*). A point of interest, however, is that, at the Stuart Nursery, the seedlings in the mulched plots had a greener color than those in the unmulched.

Relation between method of sowing and time required for weeding

An experiment conducted by the administrative staff relative to time required to weed beds sowed in drills lengthwise of the bed, in drills crosswise, and sowed broadcast showed a slight advantage for the cross-drills. The lengthwise-drilled beds required as long to weed as the broadcast-sowed. Hoes were used on the drill-sowed beds whenever greater efficiency could be obtained by doing so. Broadcast beds were hand weeded only.

SUMMARY AND CONCLUSIONS

1. Weed eradication is one of the major problems at the Stuart Forest Nursery, near Pollock, La.

2. Weeding costs in 1934 were $1.12 per thousand seedlings; in 1935 they were 22 cents per thousand. The chief cause of the high cost in 1934 was the use of an old-field site already infested with weeds. The 1935 area was new ground, cleared from forest.

3. Hand weeding is the principal method of controlling weeds at the Stuart Nursery. From 4 to 7 weedings are required per year, varying with the site and degree of infestation. A small hand tool called a spud is used to advantage. Benches to sit on were tried but were discarded. Long-handled, triangular beet-hoes used to remove weeds between drills of seedlings were found to be practicable in early weedings. Where weeds were numerous the hoes saved as much as 40 percent in time. They cannot be used after the seedlings become large, as some injury results from nicking the bark and through the wounds thus made fungi enter to attack the trees. A patrol is maintained during the summer and fall months for locating and removing weeds which are going to seed in the beds. Where very serious perennial weeds, such as coco-grass, have been found, the soil has been dug up, pulverized, and sifted to remove underground parts. Chemical weeding is yet in the experimental stage.

4. The heavy weeding job falls in May, June, and July.

5. Continuous cultivation is a valuable weed-control measure. In one southern nursery the weeding cost for 1934, on beds placed on land that had been fallow for some years, was more than 4½ times as great as for beds on land that had been rotated with seedbeds and cover crops for several years. Deep plowing, although it probably destroys many weed seeds, is not entirely effective. Some weed seeds are known to remain viable for many years when buried in the soil.

6. As weed pests, grasses and forbs are about equal in importance at the Stuart Nursery. Some species, such as coco-grass, Johnson grass, and Bermuda grass, are particularly difficult to eradicate. Other species, such as *Fimbristylis geminata, Aristida longespica,* and *Polypremum procumbens* are a nuisance because of their abundance.

7. Some of the more important genera of weeds which occur at the Stuart Nursery are listed on page 4.

8. The Southern Forest Experiment Station's work upon weeds during 1935 has consisted chiefly of collection and identification of plants in and near the nursery, preservation of the specimens in the herbarium, determination of seasonal succession and life history of weeds, and simple experiments in chemical and mechanical control. More than 100 species of weeds have been collected, most of which occur in the beds. A list of weeds at the Stuart Nursery is included in this paper and brief descriptions of several important weeds are given.

9. Zinc sulphate at the rate of 6.00, 8.00, and 10.00 grams per square foot; zinc chloride, 3.75, 5.00, and 6.25 grams; and sulphuric acid, 6.00, 8.00, and 10.00 grams, were applied to plots 24 hours before sowing to test the effect of these chemicals on pine germination, survival, and growth, and on weed germination and survival. Three species of forbs were sowed in the plots. No grasses were sowed but the effect of the chemicals on the grass seedlings which came in naturally was studied. The top 2 inches of soil was steamed for 1 hour to kill weed seeds already present. The following conclusions were drawn from the experiment:

a. Weeds germinate in the presence of these chemicals in the concentrations used.

b. All concentrations of zinc sulphate and zinc chloride are effective in killing forbs after germination.

c. Sulphuric acid was not effective in killing weeds.

d. The total germination of slash pine was not affected by the chemicals. The rapidity of germination was slighty increased by preapplication of zinc sulphate, 10 grams per square foot, but slightly decreased by all other treatments.

e. The final survival of slash pine was high for all treatments except the zinc chloride, 10 grams, application.

f. Averages of stem height, stem diameter, root length, and root development of treated seedlings compared favorably with those of the untreated check.

g. Steaming the soil for 1 hour was not sufficient to kill all weed seeds.

10. Paper mulch was tried as a weed-control method. No reduction in weeds or weeding time resulted. In view of the cost and time required to lay the paper, mulching cannot be justified. The pine seedlings in the mulched plots had a greener color, however, than those in the check plots.

11. There was very little difference in time required to weed beds where the seeds were sowed in drills lengthwise of the bed, crosswise of the bed, and sowed broadcast. The slight difference shown was in favor of the cross-drilled beds.

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